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SHORT COMMUNICATION

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Defensive behaviour exhibited by the yellow-striped poison frog (*Dendrobates truncatus*) in response to simulated predation

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Anurans use a diversity of behavioural strategies to avoid being preyed upon. By adopting sudden postures or displays (deimatic behaviours) potential predators may be distracted or startled, and among aposematic anurans this may act to increase conspicuousness (Skelhorn et al., 2015; Umbers et al., 2017; Toledo et al., 2011). Body-raising is one type of deimatic behaviour in which anurans stretch out their appendages and raise their bodies off the ground (Toledo et al., 2011). This has been described in certain members of the Hylidae, Leptodactylidae, Leiuperidae, Bufonidae, and Dendrobatidae (Toledo et al., 2004 & 2011; Blanchette & Saporito, 2016 & 2017). Among dendrobatids, body-raising has been reported in the aposematic *Ameerega flavopicta* in the field (Toledo et al., 2004), and most recently in *Dendrobates auratus* in the laboratory and field (Blanchette & Saporito, 2016, 2017). Although present in two different genera of dendrobatids, body-raising behaviour among other species, and in particular other members of the genus *Dendrobates*, remains unknown. Therefore, to determine if other members of the genus *Dendrobates* (comprising five species, Frost, 2019) also exhibit body-raising, we performed simulated predation experiments identical to those of Blanchette and Saporito (2016) with two additional species: *D. tinctorius* and *D. truncatus*. These two species were chosen because of their phylogenetic relationship with *D. auratus* (a species known to exhibit body-raising), wherein *D. auratus* and *D. truncatus* are sister species and form a distinct clade within *Dendrobates* that is different from *D. tinctorius* (Grant et al., 2017).

We undertook two similar predation simulation experiments; one for each frog species. The frogs were held in four 38 L glass terraria, two for each species, with sphagnum moss bedding and two small plastic cover objects (11 cm x 7 cm). The terraria were maintained at around 23 ˚C, a relative humidity of greater than 85 %, and on a 12-hour light:dark cycle. The frogs were provided with fruit-flies (*Drosophila melanogaster*) daily. Predation was simulated in the terraria by gently picking up and releasing individual frogs (three times, in succession) with a pair of 7.5 cm pressure sensitive forceps (Williams et al., 2000; Blanchette & Saporito, 2016). Experiment 1 involved four adult captive-bred *D. tinctorius* (average SVL = 24.9 mm); two frogs in one terrarium were 'preyed upon' every day for 94 days (05 February 2018 - 09 May 2018), whereas the two frogs in the other terrarium were 'preyed upon' every other day for 133 days (05 February -17 June 2018). Experiment 2 consisted of five adult captive-bred *D. truncatus* (average SVL = 20.2 mm), two in one terrarium and three in the other. All these frogs were 'preyed upon' every other day for 143 days (01 June - 21 October 2019). The simulated predation was performed at random times during the photophase (06.00h to 18.00h). No frogs were harmed during the study, and the experimental procedure was approved by the John Carroll University, Institutional Animal Care and Use Committee, protocol #1700.

None of the *D. tinctorius* exhibited body-raising behaviour; however, after 101 days, *D. truncatus* began to exhibit body-raising behaviour in response to simulated predation. Body-raising consisted of *D. truncatus* slightly extending their front and rear legs, arching their dorsal surface, and pointing their snout towards the ground (Fig. 1). The behaviour was observed initially in one individual, but by the end of the experiment, three of the five individuals exhibited the same behaviour. Although the behaviour was originally elicited only following simulated predation, once individual *D. truncatus* began body-raising, they also immediately body-raised when they were exposed from under a cover object (similar to Blanchette & Saporito, 2016, 2017).

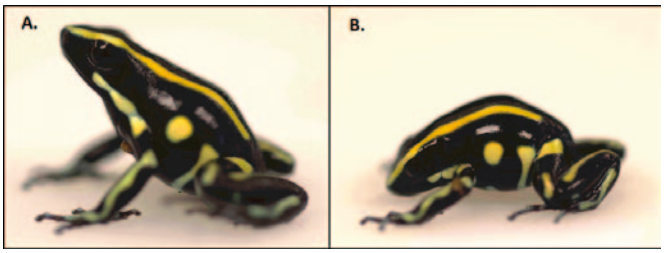

Figure 1. Adult *D. truncatus*: **A.** In a non-defensive stance, **B.** Exhibiting body-raising behaviour following simulated predation

Body-raising due to simulated predation was previously reported in captive, laboratory-raised *D. auratus* (Blanchette & Saporito, 2016), and is identical to the present report of body raising in *D. truncatus*. Although originally described in captive *D. auratus*, body-raising was also described in a natural population of *D. auratus* in Costa Rica (Blanchette & Saporito, 2017), suggesting the same is likely true of *D. truncatus*; however, this remains to be examined. As a defensive behaviour, body-raising in dendrobatids may function in more than distracting or startling potential predators. Aposematic dendrobatids are conspicuously coloured/patterned and also possess alkaloid defences, features that work together to

deter potential predators (Saporito et al., 2012). Therefore, body-raising (and in particular, dorsal arching) in dendrobatids would increase the exposure of a frog's dorsal region, a body region with greater concentrations of alkaloids (Saporito et al., 2010), to potential predators, while also increasing their dorsal conspicuousness (Toledo et al., 2004; Saporito et al., 2010; Blanchette & Saporito, 2017).

Our findings that only *D. truncatus* exhibits body-raising are consistent with the hypothesis that *D. truncatus* and *D. auratus* are sister species, and suggests that this behaviour may be restricted to this lineage. Conversely, the absence of body-raising in *D. tinctorius* suggests this behaviour may be absent in other *Dendrobates*; however, this will require further study, with particular attention on its presence in *D. leucomelas*, the sister species of *D. tinctorius* (Grant et al., 2017). It will also be of interest to examine the occurrence of this defensive behaviour in other dendrobatids, including members of the genus *Adelphobates* (which is the sister taxon of the genus *Dendrobates*; Grant et al., 2017), as well as other members of the genus *Ameerega*.

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